Division of Palaeontology
H. M. Ami, with compliments of the writer
Separates

The Caves and Potholes at Rockwood, Ont.

By Prof. J. Hoyes Panton, M. A., F. G. S.

The following is the full text of the paper read by Prof. Panton on the above subject at the meeting of the Guelph Scientific Society on the 13th inst:—

Some time ago while on a trip to Rockwood, with students of Geology from the Agricultural College, for the purpose of showing them some examples of how water acts upon limestone I was forcibly impressed by a most interesting series of Potholes found in that district, not far from where the somewhat well known caves are seen.

So impressive were these phenomena, that for three consecutive holidays, the students made their way to Rockwood, and on two of the occasions, were accompanied by myself.

A thorough examination of the locality was made, and data collected, which I purpose placing before you this evening, and which should be interesting to a Society that has been established for the purpose of developing the history of our neighborhood whether it be written upon the rocks or pages of a more perishable character.

In treating the subject, the following divisions are naturally presented:—1. The location of the Caves and Potholes; 2. A description of them; 3. An explanation of their formation; 4. Theories concerning the origin of the phenomena, that caused their formation.

1—LOCATION.

Rockwood is a small village on the line of the Grand Trunk Railway, situated about 8 miles east of Guelph, and 42 west of Toronto. Leaving the station and proceeding in the direction of the village, you very soon observe that you are in a place well named—Rockwood, from the amount of rock in the vicinity. Along the river, which passes through the village are striking exposures of rock, at some places escarpments 50 to 70 feet high made up largely of massive layers of Magnesian limestone, belonging to the Niagara formation of the Silurian system. Fossils are not numerous, Crinoid stems are by far the most common; a few shells occur, and some fragments of coral, especially the genus Favosites. The fragmentary remains of the Orthoceras are seen at some places, but the fossils are neither common enough, or so well defined as to work up the zeal of young geologists. However, after you have passed over the bridge that leads to some mills and the large quarries and lime kilns near by, you reach localities well suited to arouse enthusiasm in the mind of young students in science. The presence of three large lime kilns demonstrate, that this stone produces excellent lime, exceeding strong and well adapted for building purposes.

As you pass westward, along by the quarries, you obtain a fine view of the escarpment on both sides of the so called river and grand monuments of denudation are before you. In the distance about half a mile is the "Pinnacle" a large isolated piece of high rock, standing midway in the upper part of the mill pond. But at your side on the south side of the road along which you are travelling, your attention is arrested by a great hole at the base of the rocks. This is the entrance to a cave, which on examination proves to be of more than passing interest. In a line almost southeast of this and only a short distance away, but on the top of the bluff, you reach a pothole which rivals some that for years have been a great source of attraction to tourists stopping at Lucerne, Switzerland. Woodcuts of these are scattered in every direction, and no one can say that he has made a proper visit to Lucerne unless he has visited the "Glacier Garden" and observed the seven potholes, that are silent monuments of glacial phenomena long since ended—Yet here at Rockwood we can get a series of potholes larger in some respects and more unique than those at which so many thousands gaze in wonder each passing year. The formation and origin of these we will consider subsequently.

2—DESCRIPTION OF THE CAVES.

The entrance to the main cave is 15 feet high and obstructed by great masses of rock, which have fallen from the roof. From the top of the cave to the summit of the overhanging rock is 40 feet of solid dolomitic limestone. Proceeding into the cavern you observe that the roof is very irregular, sinking at times to 5 feet, then rising to 7 and sinking again. At the mouth it is 29 feet wide and narrows to a width of 16½ at a distance of 36 feet from the entrance. Here it is only 5 feet high but on passing this point you reach another chamber, which widens and has at the left side a small chamber eight by six feet, but soon narrowing and dipping down till the cave seems to terminate at a point 30 feet farther than the narrow part and 66 feet from the entrance. This is as much of the cave as most visitors see, but being accompanied by students of more than ordinary pluck, endurance and zeal I was successful in securing data which will enable you to form some interesting con-

clusions about this comparatively unknown spot. Light ends here. A lantern was obtained and entering one by one a passage scarcely large enough for a human being to go through, for 8 feet, Messrs. Craig, Raynor, Patterson, Sharman, Zavitz, Bishop and Fee, wormed themselves through into another cave, shrouded in Egyptian darkness and gloom. This extends 10 feet to the left and 15 to the right i.e., has a diameter one way of 25 feet and 13½ the other.

To the left and right they found a pillar not far from where they entered; these supports seem to have been formed by the rest of the rock which once made up the solid rock being carried away. At the extremity on the right hand side the floor was very muddy, and two small caves extending still farther, one near the passage by which they entered, the other at the opposite side; the former three feet by four, the latter three feet at the opening and tapering to a point and dipping downward. Prowling about in this gloomy chamber, not high enough to proceed comfortably, for it was only about five feet in the centre, they saw stalactites and stalagmites, some of them a foot in length and four to five inches in diamater at the thick est place. The floor of this chamber also dips slightly down. Directly across they came upon another pillar-like structure, with a passage on each side, opening into another apartment, where the roof was not over three to four feet high, and gradually narrowed so as to render farther progress difficult.

This extended ten feet across and about the same in width. On the opposite side from the entrance, there is an opening leading, still farther, but the passage gradually narrows until farther advancement is stopped. Through this opening Mr. Raynor passed, and threaded his way 13 feet, and reached a point 110½ feet from the entrance to the main cave. The floor of the last chamber inclines slightly, but in this prolongation the elevation is considerable. Sounding this last floor seemed to indicate that it was hollow beneath, and from the fact that the prolongation of the former chamber, near where this was entered dips downward, it is supposed a passage from it continues and likely passes under this last floor. All through these darkened caverns a good deal of mud was encountered. Water trickling down the sides and dropping from the roof added to the gloom of these darkened recesses, where daylight has never yet penetrated, and whose walls dimly lighted by the flickering light of the lantern, presented a somewhat weird, unattractive appearance. When the explorers emerged from these inner recesses of darkness, their clothes presented quite a changed appearance and indicated that much of their travelling must have been done in a somewhat menial position, and that they had been much associated with mud and water within. A little to the left of the entrance to the main cave there is an opening, which leads to another series of chambers, extending to a distance of 59 feet.

At a point in the vicinity of the first narrow place in the main cave there is a narrow passage leading into this series, in which the apartments are not so complicated, and being dry are much more easily examined. The first is some 25 feet long and 12 wide, narrowing to a passage into the second, 10 feet across, and opening into the main cave.

The general direction of the main cave is E. by S. E. to the narrow portion, then S. E. by S.; this course is maintained till the end is reached.

The roof through the whole series is exceedingly irregular, and the floor in many parts covered with fragments of the rock, which have fallen from the roof. Stalactites and stalagmites are found only in the inner chambers, and the latter seem more common than the former. Some may have formed in the outer, but have likely been carried away by visitors.

The diagrams before you will give a clear idea of the arrangement of these subterranean passages and chambers, and their relative position to each other. The whole series may be termed one cave, consisting of six well defined caverns, and as a sort of expansion on the sides of these four small ones.

POTHOLES.

Leaving the caves and clambering up the sides of one of the quarries near by, you reach the summit of an apparent peninsula of solid rock, along each side of which a stream flows at the present time, bordered by precipitous cliffs 50 to 75 feet high. The general direction of this rocky ridge is north and south.

The streams are united about a mile farther to the north, and after passing along the sides of this marked rock elevation, they join in the vicinity of Farrish's mill, and thus forming in reality an island, which terminates at its southern extremity in a limestone cliff.

About 500 yards from the caves, and near the end of the bluff, you suddenly come upon an immense hole in the solid rock; it has an oval form, its longer diameter being 20 feet and the shorter 15; one side is 10 feet higher than the other; it lies in a slight depression in the rock, which terminates at the side of the hole, with an abrupt fall of 22 feet. At the bottom of the hole you perceive an opening 4 feet high and 2 feet wide, but of an irregular outline, this opens into a sort of valley, but it must be remembered this is 40—50 feet above the level where the streams are flowing. This valley has rock on both sides and forms a beautiful glen, at the present time a popular haunt for boys delighting to revel in the pastimes of youth.

Following in a southwest direction for some 60 yards the rock rises, and a little farther on ends abruptly with a fall of about 50 feet into the valley, through which a very insignificant stream at present passes.

On the opposite side of the valley about 100 yards wide at this place, the escarpment is fully 75 yards high. About the middle of this valley a slight elevation

of solid rock some 15 feet high occurs. It occupies a peculiar position and form, appearing as if strong currents had worn away rock material, and left this irregular outlier, as a monument of conditions no longer seen in this place, where a mere creek meanders through a well defined ravine.

In this isolated area of rock on examination you find a most interesting and instructive series of Potholes, 6 in number, to some extent in a line with the large one already referred to, as located about 150 yards to the N. E.

A more unique series could scarcely be imagined. Calling that already described as No. 1, then here we have:—No. 2, 6 feet by 5 and 7 feet deep; No. 3, 1 foot by by 1 and 3 feet deep; No 4, 6 feet by 6 and 12 feet deep; No. 5, 8 feet by 4½ and 8 feet deep; No. 6, 6 feet by 6 and 10 feet deep; No. 7, 12 feet by 6 and 3 feet deep; No. 1, 20 feet by 15 and 30½ feet deep, from the highest side to the bottom and 21 from the lowest.

These holes in the rock have usually a greater diameter about half way down. The following measurements of No. 1 will show this:—Four feet from the bottom, 21⅔ by 18 feet; midway, 23 5-6ths by 19½ feet; six feet from the top, 25 by 19½ feet. Generally speaking the outline of a vertical section is oval.

Holes 2 and 6 are on the edge of the rock, and consequently are somewhat imperfect; from 5, which comes near the edge, there is a small hole, which opens into the valley; this enabled us to empty it and learn the nature of its contents. At first we were desirous to investigate the contents of No. 1, and with that view dug for the first day, and returned to continue the work. Much soil, fragments of rock, etc., were dug up and wheeled away, but we found no trace of rounded stones. After several hours of hard work, it was resolved to proceed to the series in the valley and explore some there.

The facilities for working at the large hole are good, inasmuch as the material could be loaded into the wheelbarrow at the bottom, and wheeled away a short distance and emptied into the ravine a few feet below. It is hoped on some future occasion members of the Society will follow up the work undertaken here, and finally clean out the bottom of this strange place.

We proceeded to No. 5 and entered upon the work of cleaning it out; only a few spadefuls of earth were taken out when some stones were found, whose rounded shape had a wonderful inspiring effect upon the workers.

They were very round, and were of an entirely different composition from the solid rock in which the hole had been excavated.

After some two hours digging the bottom was reached and a fine collection, about two pailfuls, of rounded stones was obtained, varying from 6 inches in diameter to half an inch. Many of the small stones were as round as marbles.

These sixteen before you represent some typical forms, and will enable you to form an idea of the interesting nature of these stones, whose very appearance suggest questions as to how they came to be so round, and how they got where they were found?

We had hoped to have found similar in the large Pothole, whether such will be, remains to be seen. It might possibly be, that they have rolled out through the passage at the bottom of the hole and must be sought elsewhere.

No. 3 being small was emptied and some of the finest specimens of small rounded stones were got from it. Nos. 2, 4, 6, 7 have not been examined, and it is probable that an examination of them will meet with even more gratifying results than those emptied. Having had the pleasure of seeing the Potholes at Lucerne in Switzerland, it does seem to me that at Rockwood there is as interesting a series. Along the river near the quarries 18 more or less defined holes appear, and in this locality under consideration 12 in all are found, and of these the seven more particularly described are exceedingly unique in form, position and structure, and were they near a large city would be a source of great attraction to visitors interested in the works of nature.

3—FORMATION OF THE CAVES AND POTHOLES.

In all districts, where limestone exists, it is not uncommon to find caves, especially if water is near. Water containing carbonic acid (a gas generated in the decomposition of vegetable material and largely present in the atmosphere, from them the respiration of animals; for the air expelled from their lungs is charged with it,) has a powerful disintegrating effect upon the carbonates of lime and magnesia, forming from them bi-carbonates, which are soluble in water and as such are carried away; consequently it is only a matter of time before limestone (a carbonate of lime) when acted upon by water containing this gas is completely dissolved. A mere dripping in a crevice will in time effect quite a change and form considerable of a cavity. If the quantity of water is considerable, the change is accomplished in a shorter period. Very forcible examples of this disintegrating effect of water on limestone were observed by me in Derbyshire this summer. There are ravines there which are supposed to have been formed out of the solid rock in ages long receded into the past.

These ravines were once overcapped by limestone, the cave or passage itself dissolved and carried away by water, finally the top fell in and the debris carried seaward, until now all that marks the great caves are the walls, which form escarpments along the ravine, through which a rivulet passes at the present time. Near by a great cavern (Poole's) explains the process; the entrance is narrow and low yet 12 feet in, and you reach a much wider passage, and as you proceed immense apartments are entered, so that you pass along a tortuous pathway for several hundred yards. Some of the apart-

ments are 20 by 30 feet high and 40 wide. No running stream is seen to indicate the cause, but the water trickling down the sides explains this great disintegration of the limestone; so here, coming nearer home, at Rockwood, you find caves not so extensive, but as characteristic of the action of waters as those I have been referring to.

The presence of mud in the back part of the inner caverns at Rockwood seems to indicate a connection between them and the surface through fissures in the rock. This mud bears a close resemblance to the soil which covers the rock above, and has likely been brought down by rain through these crevices. This rain charged with carbonic acid in time could easily dissolve out the rock and leave the caverns as we find them now. Frost would assist in breaking off fragments, as we find them now scattered along the floor of the cave, while the sides present a very irregular appearance.

The presence of stalactites on the roof and stalagmites on the floor, also show much dissolving of rock by water, for these structures are merely the precipitated lime from the water, which has carried it down. The water on reaching the roof evaporates, and the lime is left, this goes on adding particles of lime, until a structure is formed not unlike an icicle in form, but composed of carbonate of lime. Sometimes the drops fall upon the floor and form something of the same in form. The stalactites are sometimes hollow but the stalagmites are solid; this is owing to the one being formed on the roof and the other on the floor. In some cases, those from the roof fall and become imbedded in the material on the floor. At Rockwood the stalagmites are more common than the stalactites, seeming to indicate that the water containing lime in solution falls before evaporation takes place, and consequently a tendency for an accumulation of lime on the floor.

POTHOLES.

The Potholes, too, are no doubt the result of the action of the water, but in this case the action is more mechanical than chemical. Water must have passed over as a strong current, the place, where the potholes are now but in their first stages only a slight depression was in the rock. In these some hard stones collected and according to the strength of the current, the movement of the stones would depend; the motion produced would soon lead to a wearing away of the rock. Holes would form and deepen, as time rolled on, until a cavity would be produced not unlike a pot in outline. In all the holes examined, the diameter midway down was greater than at any other point. The stones grinding this out being harder than the rock, for you usually find they are pretty much the same as our boulders in the field withstand the wear and tear well, but in the course of time they become rounded and finally succeeded in making a pothole, which will vary in size according to the length of time the grinding has continued, the force of the current and the hardness of the rock acted upon. To-day we see no water near some of these holes, but we find that when the loose soil in the bottom of the holes is dug up it contains innumerable rounded stones of all sizes from a marble to that of a common ball.

have already said the mechanical action of stones and water upon the limestone, in which we find these holes, have affected the condition of things we at present observe. There are two ways in which these currents of water may have acted.

4—THEORIES OF PHENOMENA.

1. That of a great river, which filled the whole space between the highest banks at Rockwood, a stream bearing along a great body of water, with a strong current As time rolled on it gradually lessened in volume and formed two streams, running along the valleys in which, we find the streams of to day, but much larger than they. At some period in this great river's existence it flowed across the depression, where you see the largest Pothole, and flowing over the precipice pursued its course along the line in which we find the other Potholes.

2. The water may have been a current under a glacier as we see in some cases at the present time in Alpine districts. A crevasse (crack) may occur miles from the end of a glacier, into this water formed on the surface, as it pushes its way into warmer localities, falls and finally makes its way out under the great stream of ice. Such an under current getting into a depression in the rock, aided by stones from the glacier would be sure to produce Potholes. This is the origin of those at Lucerne. In such cases you are likely to find, that the stones derived from the glacier that did the work are large, and that the surface of the rock is much abraded illustrating glacial *strial* very impressively.

At Rockwood Potholes we so far have not been been able to discover glacial markings, and among the rounded stones none exceeding six inches in diameter, and thus are inclined to think these holes have been worked out by the water of a river rather than that found beneath a glacier. However as further information is secured we may be led to modify the conclusions presented to-night,